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SECTION 02554 - WASTEWATER COLLECTION SYSTEM

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PART 1 - PRODUCTS

Materials used in the work shall be those named in the Bid Proposal. In multiple type bids, the selection of the type of material will be at the option of the Owner. Material and equipment used in the work shall conform to one of the following:

1.01 SEWER PIPE:

A. Gravity Sewer

Unless specified otherwise the type of pipe shall be:

Depth	Type
Less Than 4'	Ductile Iron
4' and Greater	PVC-SDR 26

4' to 20' (Note: The maximum allowable depth shall be 20' (feet) from proposed grade).

1. PVC Pipe - Shall be SDR 26 polyvinyl chloride plastic and shall meet all requirements of ASTM D-3034, latest revision. PVC pipe shall be installed in accordance with ASTM D-2321, latest revision. All pipe shall be suitable for use as a gravity sewer conduit and shall be green in color. Provisions must be made for contraction and expansion at each joint with a rubber ring. Pipe sizes and dimensions shall be as shown in the table below. Standard laying lengths shall be 13'(feet)(± 1-inch) for all sizes. Fittings shall meet the same specification requirements as the pipe.

Nom. Size	Outside Diameter Average	Min. Wall Thickness
4"	4.215"	0.162"
6"	6.275"	0.241"
8"	8.400"	0.323"
10"	10.500"	0.404"
12"	12.500"	0.481"

Tests on PVC Pipe - Shall be designed to pass all tests at 73E F. (± 3E F.)

2. Ductile Iron - Shall conform to ANSI A 21.50 (AWWA C 150) latest revision, ANSI A 21.51 (AWWA C 151) latest revision and ASTM A-746 latest revision. All pipe shall be thickness Class 50 or greater unless otherwise noted. All ductile iron pipes

and fittings shall be bituminous coated approximately 1 mil. thick on the outside and lined with Protecto 401 Ceramic Epoxy or NovoCoat SP-2000W on the inside. Fittings shall meet the same specification requirements as the pipe.

a. Coating on the outside shall be a bituminous coating approximately 1 mil thick. The finished coating shall be continuous, smooth, neither brittle when cold or sticky when exposed to the sun, and shall be strongly adherent to the iron.

b. Protecto 401 Ceramic Epoxy interior lining shall conform to ASTM E-96, ASTM B-117, ASTM G-95, ASTM D-714.

The interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401 Ceramic Epoxy. Interior lining shall not be applied below 40 degree F. Only less than 4.0 mils loss of interior coating is acceptable after one million cycles on a +/- 22.5^{o} sliding aggregate slurry abrasion tester using a sharp natural siliceous gravel with a particle size between 2mm and 10mm. Lining application, inspection, certification, handling and surface preparation of the area to receive the protective coating shall be in accordance with the Protecto 401 manufacturer specification and requirements. Lining shall not be used on the face of the flange.

c. NovoCoat SP-2000W interior lining shall conform to ASTM D4060-90, ASTM D4541, ASTM G95-87, ASTM D149-91, ASTM D2794-92, ASTM E 96-93, ASTM B117-85, ASTM D2240

Within 8 hrs of surface preparation, the interior of the pipe shall receive 40 mils average and a minimum of 35 mils dry film thickness. No lining shall be applied when the substrate or ambient temperature is below 40° F. The surface shall be dry and free of dust. If flange pipe or fittings are included in the project the lining shall not be used on the face of the flange.
Due to the tolerances involve, the gasket area and the spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum. The coating, SP-2000W, shall be applied by brush to ensure coverage. Care should be taken that the coating is smooth without excess buildup in the gasket seat or the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

B. Force Main Pipe

1. PVC Pipe - Plastic pipe shall be PVC Class 200, C-900 for 12"(inch) and smaller and Class 200, C-905 for 14" (inch) and larger. All pipe shall conform to ASTM D-2241 and be installed in accordance with ASTM D-2321.

Pipe shall bear the National Sanitation Foundation seal of approval and shall comply

with the requirements of Type I, Grade I (PVC 1120) of the ASTM resin specification D-1784. Certificates of conformance with the foregoing specifications shall be furnished with each lot of pipe supplied.

PVC pipe for force mains shall be the latest revision APWA color code green in color, and shall be furnished in nominal 18 to 20'(foot) laying lengths unless otherwise noted.

2. Ductile Iron Pipe - Shall conform to AWWA C-150, AWWA C-151 and ASTM A-746 latest revisions. All pipe shall be thickness Class 50 unless otherwise noted.

Coatings and Linings: All ductile iron pipes and fittings shall be bituminous coated approximately 1 mil. thick on the outside and lined with Protecto 401 Ceramic Epoxy or NovoCoat SP-2000W on the inside.

a. Coating on the outside shall be a bituminous coating approximately 1 mil thick. The finished coating shall be continuous, smooth, neither brittle when cold or sticky when exposed to the sun, and shall be strongly adherent to the iron.

b. Protecto 401 Ceramic Epoxy interior lining shall conform to Permeability rating ASTM E-96-669366, Salt Spray ASTM B-117-85, Cathodic Disbondment ASTM G6-95, and Immersion Testing ASTM D-714-87.

The interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401 ceramic epoxy. Interior lining shall not be applied below 40°F.

Lining application, inspection, certification, handling and surface preparation of the area to receive the protective coating shall be in accordance with the Protecto 401 manufacturer specification and requirements. Lining shall not be used on the face of the flange.

c. NovoCoat SP-2000W interior lining shall conform to ASTM D4060-90, ASTM D4541, ASTM G95-87, ASTM D149-91, ASTM D2794-92, ASTM E 96-93, ASTM B117-85, ASTM D2240

Within 8 hrs of surface preparation, the interior of the pipe shall receive 40 mils average and a minimum of 35 mils dry film thickness. No lining shall be applied when the substrate or ambient temperature is below 40° F. The surface shall be dry and free of dust. If flange pipe or fittings are included in the project the lining shall not be used on the face of the flange.
Due to the tolerances involve, the gasket area and the spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum. The coating, SP-2000W, shall be applied by brush to ensure coverage. Care should be taken that the coating is smooth

without excess buildup in the gasket seat or the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

1.02 SEWER PIPE JOINTS:

A. Gravity Sewer Pipe

1. Joints for PVC Pipe - Shall be integral wall bell and spigot with a rubber ring gasket. The joints shall conform to ASTM D-3212 latest revision and the gaskets shall conform to ASTM F-477 latest revision.

2. Joints for Ductile Iron Pipe - Shall comply with the requirements of 1.02 B.2.

B. Force Main Pipe

Joints shall be in accordance with ASTM D-3036. All PVC fitting must have NSF-61 approval and must comply with, or exceed AWWA C907. Saddle type fittings shall not be used.

1. Plastic pipe shall be jointed by means of a rubber ring bell joint which shall be an integral part of the barrel or solvent welded at the factory. The joints shall have a space to provide expansion and contraction of the pipe without leaking. Fittings for plastic pipes shall be PVC with ring tightened rubber joints; or ductile iron with adapters to PVC pipe. Pipe shall be manufactured to ductile iron pipe equivalent outside diameter.

   The bell shall consist of an integral wall section with a bonded-in solid cross section elastomeric ring which meets the requirements of ASTM F-477 and ASTM D-3139. The bell section shall be designed to be at least as hydrostatically strong as the pipe wall and meet the requirements of UNI-BELL-B-11.

   Each standard and random length of pipe shall be tested to two times the rated pressure of the pipe for a minimum of 5 seconds. The integral bell shall be tested with the pipe.

2. Ductile Iron Joints – For various applications should meet the below criteria:

   a. Flanged Joints: Shall conform to ANSI Specification 21.2(AWWAC–150). Flanges shall be Class 125. Gaskets for flanged pipe and fittings shall be 1/16"(inch) ring gasket of red sheet rubber. Bolts and bolt studs shall conform to ANSI Specification B 16.1 (AWWA C-153).

b. Mechanical Joints: In cast and ductile iron pipe shall conform to ANSI Specification A 21.11 (AWWAC-111). All glands shall be made of ductile iron only.

c. Push-On Joints: Shall have a rubber gasket that fits into a retainer recess in the bell and produces a watertight joint when the spigot is pushed home.

d. Restrained Joints - Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to "Megalug" or push-on type joints equivalent to "Lock-Ring," "TR Flex", or "Super Lock" and shall have a minimum rated working pressure of 250 psi. Mechanical joint retainer glands shall comply with the manufacturer's specifications for the pipe material (ductile iron vs. PVC).The joints shall be in accordance with the applicable portions of ANSI/AWWA C111/A21.11. The manufacturer of the joints shall furnish certification, witnessed by an independent laboratory, that the joints furnished have been tested at a pressure of 500 psi without signs of leakage or failure. All wedge assemblies and related parts of restraint devices shall be processed through an iron-phosphate spray, rinse and drying operation in preparation for coating application. The coating shall consist of a minimum of two coats of liquid Xylan® fluoropolymer coating with heat cure to follow each coat. All casting bodies of restrained joints shall be surface pre-treated with an iron-phosphate spray, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. The coating shall be a polyester based powder to provide corrosion, impact and UV resistance. The coating system shall be Mega-Bond™ by EBAA Iron, or approved equal. Restrained joints shall be capable of being deflected after assembly. Restrained joints shall have a preset deflection of no more than 5 degrees and shall be able to take up 3 degrees of deflection after burial.

e. Couplings - All connections of new sewer pipe to existing sewer pipe shall occur using rigid couplings. Flexible (e.g. Fernco) couplings shall not be allowed. Couplings shall be PVC double bell type, ductile iron mechanical joint solid sleeve type or ductile iron straight and transition type (e.g., Dresser Couplings) depending on the application.

C. Ductile Iron Fittings

Fittings shall consist of bends, tees, crosses, caps and plugs, reducers, tapped tees, sleeves, etc. All fittings furnished shall be cast and machined at one foundry location to assure quality control and provide satisfactory test data. Fittings shall have cast on

them the pressure rating, nominal diameter of openings, manufacturer's name, foundry location, plant code, and degrees of fraction of the circle. Cast letters and figures shall be on the outside body of the fitting. Ductile iron welded on outlets is not acceptable.

a. Fittings for Push-On and Mechanical Joint Pipe Shall be ductile iron, manufactured in accordance with ANSI A21.10 (AWWA C-110) or ANSI A21.53 (AWWA C-153) standards. Fittings shall be designed to accommodate the type of pipe used.

b. Fittings for Flanged Pipe: Shall be manufactured in accordance with ASNI B16.1, Class 125 flanges. Bolt circles and bolt holes shall also meet ANSI B16.1.

D. Air Release Valve - Shall be designed for sewage service. The valve shall be constructed of a cast iron body, stainless steel or bronze trim, and stainless steel float. The inlet shall be 2" (inches), 5/16" (inch) orifice and have a venting capacity of 35 c.f.f.a.m, however, at 10lbs. working pressure it should not vent less than 25 cfm of free air. The working pressure shall be as specified in the contract. Sewage air release valves shall be Crispin UX20 or equal. Piping, nipples, and plugs shall be Schedule 40, type 316 stainless steel. Air release valves shall be installed at all high points in the force main and/or as designated by the engineer. It shall conform to the detail shown. A copy of the O&M manual shall be given to the City prior to acceptance. Provide 3" (inch) diameter or larger clean out port.

The manhole and installation of the valve shall be in accordance with the City of Savannah Standard Construction Detail, 5-11. Prior to deciding on the location of any air release valve, the Contractor shall provide the Engineer with an accurate profile of the installed force main so that high points in the system can be determined. The locations of the air release valves shall be field adjusted based on the locations of the high points.

1.03 MANHOLES:

A. Precast Concrete - Precast manholes shall have a minimum wall thickness of five inches. Cone sections shall have a minimum wall thickness of 8" (inch) at their top. Manholes shall be manufactured with 4,000 P.S.I. concrete, type II cement that meet ASTM C-150 and absorption shall not exceed 6%. Wall reinforcement shall meet ASTM C-478 and also have a No. 4 rebar hoop around each pipe opening. The flat top slab sections shall handle HS-20 traffic loadings. Bottom slabs shall be five inches thick and be reinforced with No. 4 rebar at 9"(inch)O.C.E.W. All items shall be wet cast. Dry casting or low slump concrete will not be allowed. All bases will have proper lifting hooks in the bottom slabs (min. of 3) and there shall be no penetrating lifting holes on any structures. No holes will be allowed within 6" (six) inches of any joint on structures. All manholes shall have a coating as per Section 02555.

This shall be the minimum requirements for wall and slab thickness/rebar. It shall be the responsibility of the Contractor to insure that the manhole(s) are designed properly for the loading conditions as indicated on the plans. Should the loading conditions require greater structural integrity than the minimum, as herein specified, it shall be the responsibility of the Contractor to utilize the maximum design.

Manhole sections shall be free from large honeycomb, cracks, spalls, large chips, exposed reinforcing, and broken bells and spigots. Edges of bells and spigots shall be even and straight. Mastic shall be "Ram-nek," or equivalent, with primer. The primer shall be applied to all contact surfaces of the manhole joint at the factory in accordance with the manufacturer's instructions.

B. Frames and Covers - Manhole frame and covers shall be out of gray cast iron per ASTM A48, Class 35 without perforations and suitable for addition of cast iron or steel rings for upward adjustment of top. The word "SANITARY" shall be cast into the face of the cover in 1.5"(inches) to 2"(inch) letters raised flush with the top of the cover. Frames and covers shall have machine ground seats, a coating of coal tar pitch varnish, and be an approved equal to U.S. Foundry and Manufacturing Corp. No. USF 195-ORS. All manhole rings and covers shall be made water-tight by means of dovetail grooves and gaskets in the cover. Provide circular cover with two (2) pulls for removing manhole cover spaced at 180 degrees and weighing not less than 120 pounds.

Proof Load Testing: Traffic service castings shall have a first article proof load test conducted and the results of that proof load test shall be made available to the City upon request. The proof load test shall be conducted in accordance with the methods and procedures outlined in AASHTO M306-04, Section 5, Proof Load Testing. The casting shall be tested on a suitable and calibrated load testing machine and the casting shall hold a 40,000 pound proof load for one minute without experiencing any cracks or detrimental permanent deformation.

C. Pipe Connections - Pipe/manhole connector shall be one piece rubber boot secured to pipe with stainless steel clamp band and to the manhole with stainless steel expansion ring. Kor-N-Seal Boot, A-lock or equal. Space between Kor-N-Seal boot and pipe OD shall be filled with non-shrink grout.

D. Steps – Steps in manholes shall be 3/8"(inch)steel rods coated with polypropylene material.

1.04 CASING:

A. Casing pipe shall be steel conforming to ASTM A-139, minimum yield strength point of 35,000 psi of the diameter shown on the drawings at each crossing. The minimum wall thickness shall be 0.25"(inches) for 24" (inch)diameter and smaller, and 0.375"(inch) for larger diameters.

The pipe ends shall be tapered where welding is required. Full pipe lengths shall be provided. No pipe casing lengths less than 8'(feet) shall be allowed unless approved by the Owner. All casing welds shall be continuous and made by a certified welder. All pipe within casings shall be restrained joint ductile iron.

B. CASING SPACERS:

Casing Spacers shall be bolt on style with a shell made in two (2) sections of Heavy T-304 Stainless Steel. Connecting flanges shall be ribbed for extra strength. The shell shall be lined with a PVC liner. All nuts and bolts shall be 18-8 Stainless Steel. Runners shall be made of Ultra High Molecular Weight Polymer with inherently high abrasion resistance and a low coefficient of friction. Runners shall be supported by risers made of Heavy T-304 Stainless Steel. The combined height of the supports and runners shall keep the carrier pipe a minimum of 0.75"(inch) from the casing pipe at all times. Casing Spacers shall be as manufactured by Cascade Waterworks Manufacturing Company, or approved equal.

1.05 SERVICE CONNECTIONS:

A. Tee-wyes shall be a minimum of 4"(inches)and shall be the same diameter as the run of the pipe. They shall be of the same material as the sewer main. Tee-wyes shall be used for all service connections to new sewer main.

B. Service Saddles: Service Saddles shall be flexible sewer saddles with double stainless steel straps or PVC Inserta Tees **TM**. Service Saddles shall only be allowed for new service connections to existing sewer mains.

1.06 LATERALS:

Laterals under traffic loads shall be ductile iron conforming to Paragraph 1.01.A, with push-on joints. Laterals under non-traffic loads can be Polyvinyl Chloride with bells and natural rubber rings for jointing, conforming to Paragraph 1.01.A. All PVC sewer laterals shall be constructed with SDR 26 pipe.

A saw cut "S" shall be cut in the top of the curb directly over the lateral location. Tracing wire shall be adhered to the lateral from the main and up to the cleanout.

1.07 METAL DETECTOR TAPE:

Detector tape shall be installed over all nonmetallic gravity sewer. The tape will be equivalent to Terra-Tape by Griffolyn co., Inc. of Houston, Texas. The tape shall be at least 2"(inches)wide and "green" with the "black" words "Caution Buried Force Main Below" or "Caution Buried Sewer Line Below" noted on the tape. The tape shall have a tensile strength of not less than 4,000 psi, a dart impact strength of not

less than 120 grams per 1.5 mils, be not less than 0.0055" (inches) thick, and include sufficient metal to allow easy detection from above ground. The detector tape shall be designed to last as long as the pipe it is installed over, even in adverse soils.

1.08 TRACING WIRE:

All force mains and sanitary sewer laterals below grade shall have a #12 gauge 30 mil insulated single strand copper wire installed directly on top of the pipe line. The wire shall be secured to the pipe with tape or other accepted methods at spacings of no more than 36" (inch) apart. Where appurtenances connect to the force main, the wire insulation shall be stripped so that the bare wires can and shall be joined securely together and wrapped with a rubberized insulation tape. The insulation tape shall completely cover all areas of the exposed wire. The insulated wire must maintain electrical continuity. In addition, tracing wire shall locate laterals by connecting cleanouts to gravity sewers. All these This tracing wire system shall be checked and tested by the contractor, in the presence of the engineer or project representative, prior to acceptance of the force main installation. All equipment, meters, detectors, etc. needed for testing shall be furnished by the Contractor.

Plastic Tracing Wire Stations equal to Rhino TriView FlexTM shall be installed every 500'(feet) along the force main. Tracing wire shall be connected to the station and shall be marked as "Sanitary Sewer Force Main."

1.09 FORCE MAIN SUBSURFACE MARKERS:

Omni-balls or equal shall be installed above force main pipe at all bends, and at least every 500' (feet) along straight pipe runs.

1.10 POLYETHYLENE ENCASEMENT:

Polyethylene encasement shall be used on all ductile iron pipe, and shall be in tube form conforming to the requirements of ANSI/AWWA C105/A21.5 latest revision. The polyethylene film shall have the following characteristics:

Tensile Strength:	1,200 psi minimum
Elongation:	300 percent minimum
Dielectric Strength:	300V/mil thickness minimum
Thickness:	Nominal thickness of .008 in. (8 mil)

1.11 STONE BEDDING:

Shall be graded crushed granite with the following gradation:

Square Opening Size	Percent Passing

1"	100%
3/4"	90 to 100%
3/8"	0 to 65%
No. 4	0 to 25%

1.12 BORROW:

Where it is determined that sufficient suitable material is not available from the site to satisfactorily backfill the pipe to at least 2' (feet) above the top of the pipe, the Contractor shall furnish suitable sandy borrow material to accomplish the requirements. The material shall have not more than 60% passing the No. 100 sieve, nor more than 20% passing the No. 200 sieve

1.13 PRODUCT REVIEW:

A. The Contractor shall provide the Engineer with a complete description of all products before ordering. The Engineer shall review and approve all products before they are ordered.

PART 2 - EXECUTION

2.01 CONSTRUCTION OBSERVATION:

The line, grade, deflection and infiltration of sewers shall be tested by the Contractor under the direction of the Engineer. The Engineer will have the right to require that any portion of the work be done in his presence and if the work is covered up after such instruction, it shall be exposed by the Contractor for observation. However, if the Contractor notifies the Engineer that such work is scheduled and the Engineer fails to appear within 48 hours, the Contractor may proceed without him. All work done and materials furnished shall be subject to review by the Engineer or project representative. Improper work shall be reconstructed. All materials which do not conform to the requirements of the specifications shall be removed from the work upon notice being received from the Engineer for the rejection of such materials. The Engineer shall have the right to mark rejected materials so as to distinguish them as such. The Contractor shall give the Project Engineer or Project Representative a minimum of 48 hours notice for all required observations or tests.

2.02 LOCATION AND GRADE:

The line and grade of the sewers and the position of all manholes and other structures are shown on the drawings. The grade line as given on the profile or mentioned in these specifications means the invert or bottom of the inside of the pipe, and the price for trenching shall include the trench for the depth below this line necessary to lay the sewer to this grade, but measurements for payment will be made only to the grade

line. Master control lines and bench marks have been provided by the Engineer. The Contractor shall be responsible for the proper locations and grade of the sewers.

2.03 EXCAVATION:

The Contractor shall perform all excavations of every description and of whatever substance encountered to the depth shown on the plans or specified for all sewers, manholes and other appurtenances. All trenches shall be properly dewatered before laying pipe, by the use of well points, pumping or other methods accepted by the Engineer. The top portion of trenches may be excavated with sloping or vertical sides, except that the width of trench to a height of 2'(feet) above the top of the pipe shall not exceed 2'(feet) greater than the diameter of the pipe. A minimum of 6" (inches) of stone bedding shall be required for all sewers and force mains. The bedding shall extend to one-half of the pipe diameter.

Where the character of the soil is such that the Engineer determines it unsuitable for pipe bedding, an additional foot of excavation will be authorized and the trench backfilled with stone. Excavation in excess of the depths and widths required for sewers, manholes and other structures shall be corrected by backfilling with stone to the proper grade.

The limit of excavation shall be such to allow for placing and removing forms, installing sheeting, shoring, bracing, etc. The Contractor shall pile excavated material in a manner that will not endanger the work and will avoid obstructing sidewalks, driveways, power poles, etc. Drainage shall be kept clear.

2.04 BRACING AND SHEETING:

The sides of all trenches shall be securely held by trench boxes, stay bracing, or by skeleton or solid sheeting and bracing, as required by the soil conditions encountered, to protect the adjoining property and for safety in accordance with OSHA requirements. Where shown on the drawings or where directed by the Engineer, the Contractor must install solid sheeting to protect adjacent property and utilities. The sheeting shall be steel or timber and the Contractor shall submit design data, including the section modules of the members and the arrangement for bracing at various depths, to the Engineer for review before installing the sheeting. Sheeting shall be removed in units when the backfilling has reached the elevation necessary to protect the pipe, adjoining property and utilities.

When sheeting or shoring above the elevation cannot be safely removed, it shall be left in place. Timber left in place shall be cut off at least 2' (feet) below the surface.

2.05 LAYING PIPE:

A. Gravity Sewer Installation:

All gravity sewer pipe shall be laid upgrade with spigots pointing downgrade. The pipe shall be laid in a trench prepared in accordance with Paragraph 2.03 "Excavation," so that after the sewer is complete, the interior surface shall conform on the bottom accurately to the grades and alignment fixed or given by the Engineer. All pipe shall be cleaned out and left clean. Every third joint shall be filled around immediately after being properly placed. The recommendations of the manufacturer of the particular pipe joint used shall be adhered to.

The sewer lines shall be straight and show a uniform grade between manholes. Any sags or bellies in the pipe sections shall not extend longer than 10' (feet) or hold water more than one-eighth of the pipe's inside diameter.

B. Force Main Installation

Depth of Pipe – The Contractor shall perform excavation of whatever substances are encountered to a depth that will provide a minimum cover over the top of the pipe of 36" (inches) from the proposed finished grade, for pipe 12" (inches) and smaller. Pipe larger than 12" (inches) in diameter shall have 48" (inches) of cover from the finished grade. A maximum cover of 60" (inches) from finished grade shall be used unless approved by the City to avoid a conflict. If the cover will be less than 36" (inches), ductile pipe shall be used.

The force main shall be laid in a ditch prepared in accordance with Paragraph 2.03 "Excavation", so that after the force main is complete, the interior surface shall conform on the bottom accurately to the grades and alignment fixed or given by the Engineer. Special care should be taken to provide a firm bedding in good material, select borrow, stone backfill or Class "A" concrete, as authorized, for the length of each joint and one-half of the circumference. Install stone bedding to a depth of 6" (inches) beneath the FM pipe and up to the spring line of the pipe. Holes shall be provided to relieve bells from bedding strain, but not so large as to allow separation of the bell from the barrel by settlement after backfilling. All pipe shall be cleaned out and left clean. Every third joint shall be filled around immediately after being properly placed. The recommendations of the manufacturer of the particular pipe joint used shall be adhered to.

2.06 METAL DETECTOR TAPE:

As a part of the installation of gravity or force main sewer, the Contractor shall place metallic detector tape, suitably coded, over the installed pipes at a depth not to exceed 18" (inches) below the finished surface.

2.07 SEPARATION BETWEEN WATER & SANITARY SEWERS:

Water mains and/or laterals shall not be laid closer than 10 feet horizontally to a

sanitary or storm sewer without written instruction from the engineer. Some deviation may be allowed on a case by case basis if approved by the City for installation of the water main closer to a sewer, provided that the water main is laid in a separate trench, such that the bottom of the water main is at least 18 inches above the top of the sewer. In no case, shall the water and sewer lines be closer than 5' (feet) horizontally edge to edge. Water mains crossing sewers should be laid to provide a minimum vertical distance of 18" (inches) between the invert of the water main and the top of the sewer line. The water and sewer lines must be ductile iron when laid in violation of the separation requirements. One full length of water pipe shall be located so both joints will be as far from the sewer as possible.

2.08 STONE BEDDING:

Stone bedding shall be installed 6" (inches) below all sewer pipes and to one-half of the pipe diameter. Stone shall be placed 6" (inches) deep and 2' (feet) wider than the pipe at the barrel, and up to the springline of the sewer pipe. The pipe shall be carefully bedded in the stone as specified on City of Savannah Detail S-26, or in accordance with the manufacturer's recommendations.

2.09 CONNECTIONS TO EXISTING SEWER MAINS:

Connections to existing sewer mains may be performed with the use of two difference connections devices:

A. A saddle matching the existing main line pipe diameter with either 4" or 6" (inch) lateral connections may be used. The existing lines must be cut with a round cutter so that the opening will allow the hub of the saddle to fit inside the opening. Square holes cut with a pipe saw will not be acceptable. The saddles must be gasketed. Stainless steel straps must be used to attach the saddle to the existing sewer main. The sewer main must be protected from existing debris around the pipe from entering the line during the attachment of the saddle. The area around the existing sewer pipe must be compacted to 100% density. All saddles must be attached to the sewer main at either the 2:00 or 10:00 position. No laterals will be attached to the sewer main at the 12:00 position.

B. The other alternative to attaching sewer laterals to an existing main is by using an Inserta Tee. This device can be connected to the main by drilling an appropriate size round hole for the 4" or 6" (inch) lateral. The proper Inserta Tee for the existing sewer line pipe material must then be installed by inserting the rubber boot inside the sewer main. A PVC insert, lubricated properly, is then inserted inside the boot, then a stainless steel strap ties the boot to the insert. The insert then accepts PVC pipe of the appropriate size. The site must then be 100% compacted around the lateral. All connections to existing sewer mains must be inspected by the City prior to backfilling.

2.10 BACKFILLING:

A. All trenches and excavation shall be backfilled immediately after the pipes are laid therein, unless other protection of the pipe line is directed. The backfilling material shall be selected and deposited with special reference to the future safety of the pipes. Except where special methods of bedding and tamping are provided for, select backfill or sandy borrow shall be solidly tamped about the pipe up to a level at least 2' (feet) above the top of the pipes and shall be carefully deposited to uniform layers, each layer solidly tamped or rammed with proper tools so as not to injure or disturb the pipeline. The remainder of the backfilling of the trench shall be carried on simultaneously on both sides of the pipe in 8" - 12" (inch) layers in such a manner that injurious side pressure does not occur. The material used shall be selected from excavated material anywhere on the work site if any of this material is suitable.

Under the traffic areas the top 12" (inches) of backfill material shall be compacted to a density of not less than 100% at optimum moisture. Below the 12" (inch) line and to and including the area around the pipe the density shall not be less than 95% at optimum moisture. In areas other than traffic areas, the backfill material shall be compacted to 95% density at optimum moisture. Compaction tests shall be conducted in accordance with ASTM D-1556 or D-2922 by an independent testing laboratory. The tests are to be taken at the direction of the Engineer to average not more than 100" (foot) intervals. Laboratory Tests shall conform to ASTM D-698.

Whenever the trenches have not been properly filled, or if settlement occurs, they shall be refilled, smoothed off and finally made to conform to the surface elevation of the ground. Backfilling shall be carefully performed and the original surface restored to the full satisfaction of the Engineer immediately after the installation.

Where thermoplastic (P.V.C.) pipe is installed, the Contractor shall take precautions in accordance with ASTM D-2321, during the backfill operations so as not to create excessive side pressures, or vertical or horizontal deflection of the pipe so as not to impair flow capacity.

2.11 JACKING AND BORING:

Steel casing of the diameter shown on the plans shall be jacked and bored in the locations indicated. Joints between sections of the steel casing shall be welded by a certified welder. Boring and jacking shall be in accordance with the provisions of Section 65 of the Georgia Department of Transportation Standard Specifications. After the carrier pipe has been installed, the ends of the casing shall be sealed with Class "C" concrete after observation by the Engineer.

Where the work involves a State highway, the Resident Engineer of the State Department of Transportation shall be notified by the Contractor three (3) working days before the crossing is started. Where the work involves a railroad, the work shall conform to the requirements of American Railway Engineering Association specifications and the Division Superintendent of the Railroad shall be notified three (3) working days prior to beginning the work. Before commencing work within the rights-of-way of the railroads or highways, the Contractor shall verify that the Owner has obtained the required permits.

2.12 MANHOLES:

Manholes shall be constructed on compacted bedding material so structure is plumb and pipe inverts are at the proper extension where shown on the drawings or where directed by the Engineer. Manholes shall be installed at the end of each line, at all changes in grade, size, or alignment, at all intersections, and at distances not greater than 400' feet). The channel in the bottom of the manholes shall be smooth and properly rounded and the invert channel shall be same size as installed sewer line. Special care must be exercised in laying the channel and adjacent pipes to grade. Invert piping shall not extend inside manhole any further than 2" (inches). The slope of the invert benches shall provide a minimum of 2" higher than the crown of the pipe. The tops of manholes outside of roads shall be built to the ground surface unless otherwise shown on the plans. Manholes in roads shall be built to grades designated by the Engineer. Manhole sections with either honeycomb defects; exposed reinforcing; broken/fractured bell or spigot or cracked walls will be subject to rejection by the Engineers for use on the project. When mastic sealant is used, improperly applied primer will also be cause for rejection.

No leaks in any manhole will be acceptable. All repairs made from inside the manhole shall be made with non-shrink grout.

A 0.1' (feet) minimum drop shall be required through all manholes where the horizontal alignment change is less than 45 degrees. A 0.2'(foot) minimum drop shall be required through all manholes where the horizontal alignment change is 45 degrees to 90 degrees. Horizontal alignment changes greater than 90 degrees at a

single manhole shall not be allowed. A wide sweep invert shall be required for all manholes where the horizontal alignment change is 90 degrees.

2.13 PROTECTION OF EXISTING SANITARY SEWER SYSTEMS:

During the construction of new Sanitary Sewer Systems, the existing sanitary sewer shall be protected at the point of connection with use of a pneumatic or mechanical plug. This isolation shall remain in place until the new system is fully accepted. Provisions must be in place to prevent sediment and excess water from entering the City's existing Sanitary Sewer System.

The isolation of the new system must be performed at the Contractor's expense. Any breach of this isolation shall be resolved by the Contractor to meet City expectations and standards. The Contractor may also be liable and responsible for remediation costs due to this breach.

2.14 CLEANING:

Prior to mandrel tests, televising, and before acceptance of the gravity sewer systems, all sewer lines shall be cleaned to the satisfaction of the Engineer. Where any obstruction occurs, the contractor will be required to clean the sewers by flushing and by means of rod and swabs or other instruments. Cleaning of new sewers is to be completed without impacting the existing sewer system.

2.15 TESTING AND INSPECTION

A. Leakage Testing: Mains and Laterals

All new public and private gravity sewers and laterals shall be pressure tested a minimum of 30 days following final backfill in accordance with the Time-Pressure Drop Method specified in ASTM F1417 - Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air, latest revision. The procedure is summarized as follows:

1. Isolate the section of the sewer line to be tested using inflatable plugs or stoppers.

2. Cap all laterals and stubs using glued caps. All caps and plugs shall be securely braced to prevent blow-out.

3. One of the plugs or caps shall have an inlet tap or other provision for connecting a hose to a portable air control source.

4. Connect the air hose to the inlet tap and portable air control source. The air source equipment shall include necessary valves and pressure gages to pressurize an oil-free air source at a controlled rate into the test section.

5. Add air slowly to the test section until the pressure inside the pipe reaches 4 psi greater than the average backpressure of any groundwater submerging the pipe. (NOTE: All test pressures are measured as gage pressure, which is any pressure greater than atmospheric pressure. Since water produces a pressure of 0.43 psi per foot of depth, air test pressures must be increased to offset the depth of groundwater over the sewer line. If the groundwater is 2' (feet) or more above the top of the pipe at the upstream end, or if the required test pressure exceeds 9 psi, this test should not be used.)

6. Disconnect the air supply and allow a minimum of two minutes for pressure stabilization.

7. Measure the pressure drop over the following time period, depending on the diameter of the sewer pipe being tested (based on a maximum test section length of 400' (feet) between manholes):

8 inch:	6 minutes
10 inch:	8 minutes
12 inch:	12 minutes
15 inch:	18 minutes
18 inch:	26 minutes

8. Acceptable pressure drop over time period: Not more than 0.5 psi.

The testing shall be performed by the Contractor, and a representative of the City shall be present to observe the test. The Contractor shall be responsible for all costs associated with performing the leakage testing, locating leaks, repairing leaks, and conducting additional leakage testing as necessary until the system passes the pressure test. No gravity sewers or laterals will be accepted by the City without a passing pressure test.

B. Deflection – Mains:

It is the responsibility of the Contractor to assure that backfill is sufficient to limit deflection for all PVC pipe, 8" (inch) diameter and larger, to no more than 5% of the internal diameter of the pipe which shall be tested by a mandrel permitting no greater than maximum 5% deflection. All pipe shall be tested no sooner than 30 days after installation. All pipe not passing the 5% deflection limitation test shall be repaired or removed and replaced.

The mandrel shall be pulled through the pipe (SDR-26) with the following diameter:

Nominal Pipe Size	AV I.D.	Mandrel Diameter
8"	7.754"	7.37"
10"	9.692"	9.20"
12"	11.538"	10.96"

C. Deflection - Laterals:

It is the responsibility of the Contractor to assure that installation and backfill is sufficient to limit obstructions and deflections in the laterals. Laterals shall be tested by dropping a tennis ball in the upstream end of the pipe. The tennis ball must show up at the next downstream manhole. If not, the lateral must be repaired or removed and replaced. The tennis ball may be followed by water to help with its travel to the next downstream manhole.

D. Televising:

After the completion of successful mandrel tests and cleaning, all newly constructed sewer lines must be televised by the City prior to acceptance. Accordingly, all sewer lines, 8" (inch) in diameter and larger, that are installed within accepted public right-of-ways and easements will be televised, including those lines on private property that are connected to the public lines. Contractors will be charged a fee, currently $0.85/linear feet for all size sewers, by the City, and will be responsible for preparing the lines to insure that they are cleaned and free of debris prior to televising. Contractor shall notify the Inspector on his progress prior to the televising request. Details and procedures of this program are included in the "Televising Procedures Manual" developed by the City's Water Quality Control Department who will be providing the television services. Contractors will be responsible for becoming familiar with this manual. This Manual is available on the City's Website.

E. Compaction:

Laboratory tests of the soil shall be made in accordance with ASTM D-698. In-place density tests shall be made in accordance with ASTM D-1556 or D-2922. Results of the tests shall be furnished to the Engineer by the testing laboratory. The minimum number of tests required shall be:

Backfill over sewer in traffic areas ..... 1 per 100 linear feet or less for each 4' (feet) or depth or portion thereof.

Backfill over sewer in non-traffic areas ..... 1 per 200 linear feet or less for each 6' (feet) of depth or portion thereof.

2.16 CLOSING PIPE:

When the work or pipe laying is suspended, either for night or at other times, the end of the gravity sewer or force main pipe must be closed with a water tight cover. The Contractor will be held responsible for keeping the gravity sewer or force main free from obstruction. Plugs shall remain in pipe ends until all water is removed from the trench.

2.17 GRASSING:

Grassing of areas disturbed during construction shall be in accordance with Section 02485 - ■Grassing.•

2.18 ACCEPTANCE OF PORTIONS OF THE WORK:

The Owner reserves the right to accept and use any portion of the work whenever it is considered to the City•s interest to do so. The Engineer shall have power to direct on what line the Contractor shall work and the order thereof.

2.19 RECORD DATA:

As required under Section 1500, Paragraph 54, of the General Conditions, the Contractor is required during construction to keep accurate, legible records of the location of all new sewers, force mains, tees and laterals. This record data will include survey coordinates of all bends and fittings on the force main. These records will be made available to the Engineer before his final review for incorporation into the consulting Engineer•s Record Drawings. Final payment to the Contractor will be withheld until all such information is received and accepted.

END OF SECTION